

LB  
3054  
C2  
D422  
1996:Jan  
CURRHIST



EX LIBRIS  
UNIVERSITATIS  
ALBERTÆNSIS

---

**January 1996**



# **Chemistry 30**

## **Grade 12 Diploma Examination**



Copyright 1996, the Crown in Right of Alberta, as represented by the Minister of Education, Alberta Education, Student Evaluation Branch, 11160 Jasper Avenue, Edmonton, Alberta, T5K 0L2. All rights reserved. Additional copies may be purchased from the Learning Resources Distributing Centre.

**Special permission** is granted to **Alberta educators only** to reproduce, for educational purposes and on a non-profit basis, parts of this examination that do **not** contain excerpted material **only after the administration of this examination.**

Excerpted material in this examination **shall not** be reproduced without the written permission of the original publisher (see credits page, where applicable).

**January 1996**

# **Chemistry 30**

## **Grade 12 Diploma Examination**

### **Description**

Time: 2.5 h. You may take an additional 0.5 h to complete the examination.

This is a **closed-book** examination consisting of

- 44 multiple-choice and 12 numerical-response questions, of equal value, worth 70% of the examination
- 2 written-response questions, each worth 15% of the examination

This examination contains sets of related questions

A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

When required, a grey bar will be used to indicate the end of a set.

A chemistry data booklet is provided for your reference.

The perforated pages at the back of this booklet may be torn out and used for your rough work. No marks will be given for work done on the tear-out pages.

### **Instructions**

- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.
- You are expected to provide your own scientific calculator.
- Use only an HB pencil for the machine-scored answer sheet.
- If you wish to change an answer, erase **all** traces of your first answer.
- Consider all numbers used in the examination to be the result of a measurement or observation.
- Do not fold the answer sheet.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Education.
- Read each question carefully.
- Now turn this page and read the detailed instructions for answering machine-scored and written-response questions.

## **Multiple Choice**

- Decide which of the choices **best** completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

### **Example**

This examination is for the subject of

- A. chemistry
- B. biology
- C. physics
- D. science

Answer Sheet

●   (B)   (C)   (D)

## **Numerical Response**

- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.
- **Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.**

### **Examples**

#### **Calculation Question and Solution**

The average of the values 21.0, 25.5, and 24.5 is \_\_\_\_\_.

(Record your answer to three digits on the answer sheet.)

$$\begin{aligned}\text{Average} &= (21.0 + 25.5 + 24.5)/3 \\ &= 23.666 \\ &= 23.7 \text{ (rounded to three digits)}\end{aligned}$$

**Record 23.7 on the  
answer sheet**

→ 

2	3	.	7
---	---	---	---

0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

## **Written Response**

### **Correct-order Question and Solution**

When the following subjects are arranged in alphabetical order, the order is \_\_\_\_\_.  
(Record all four digits on the answer sheet.)

- 1 physics
- 2 chemistry
- 3 biology
- 4 science

Answer 3214

**Record 3214 on the  
answer sheet**

→ 

3	2	1	4
---	---	---	---

0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

- Write your answers in the examination booklet as neatly as possible.
- For full marks, your answers must be well organized and address **all** the main points of the question.
- Relevant scientific, technological, and/or societal concepts and examples must be identified and explicit.
- Description and/or explanations of concepts must be correct and reflect pertinent ideas, calculations, and formulas.
- Your answers **should be** presented in a well-organized manner using complete sentences, correct units, and significant digits where appropriate.

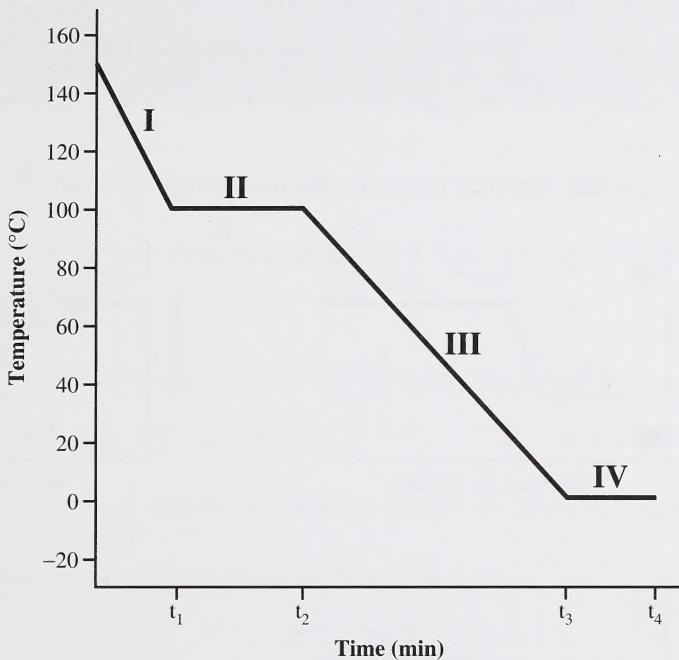
***Do not turn the page to start the  
examination until told to do so by  
the presiding examiner.***



Digitized by the Internet Archive  
in 2016

*Use the following information to answer the next question.*

The diagram shows the cooling of 1.00 mol of H<sub>2</sub>O.

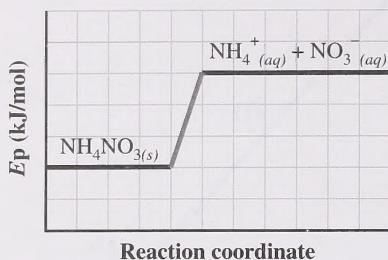


1. A change in potential energy is shown in regions
  - A. I and II
  - B. I and III
  - C. II and IV
  - D. III and IV

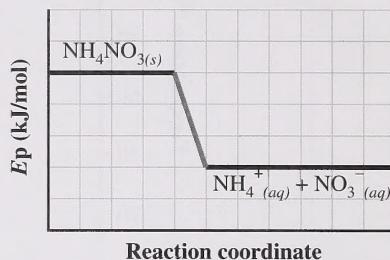
Some “cold packs” and “hot packs” contain two pouches: a small pouch containing a solid crystals and a larger pouch containing water. When the small pouch is broken, the crystals dissolve in the water in the larger pouch. If the crystals are ammonium nitrate, the temperature of the water decreases; if the crystals are calcium chloride, the temperature of the water increases.

2. The diagram that **correctly** represents the heat change involved for one of the packs is

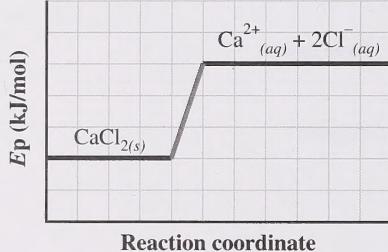
A.



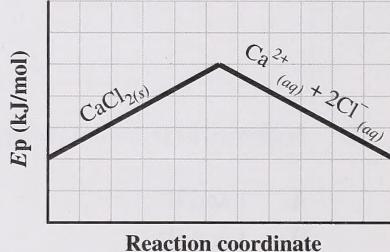
B.



C.



D.



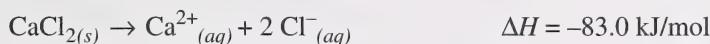
**Numerical Response**

1. The energy involved in changing the temperature of 1.00 kg of water  $5.36^{\circ}\text{C}$  is \_\_\_\_\_ kJ.  
(Record your answer to three digits on the answer sheet.)

*Use your recorded value from Numerical Response 1 to answer Numerical Response 2.*

**Numerical Response**

2. The dissolving of calcium chloride is represented by the equation



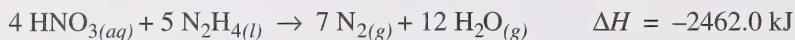
The mass of  $\text{CaCl}_{2(s)}$  required to cause the change in numerical-response question 1 is \_\_\_\_\_ g.

(Record your answer to three digits on the answer sheet.)

3. A student was asked to write, using  $\Delta H$  notation, an expression for the energy change associated with the burning of a petroleum-based fuel. A correct response to this request is

- A.  $6 \text{ C}_{(s)} + 3 \text{ H}_{2(g)} + \chi \text{ kJ} \rightarrow \text{C}_6\text{H}_{6(l)}$
- B.  $2 \text{ CO}_{(g)} + \text{O}_{2(g)} \rightarrow 2 \text{ CO}_{2(g)} + \chi \text{ kJ}$
- C.  $2 \text{ C}_{20}\text{H}_{42(l)} + 61 \text{ O}_{2(g)} \rightarrow 40 \text{ CO}_{2(g)} + 42 \text{ H}_{2}\text{O}_{(g)} \quad \Delta H = \chi \text{ kJ}$
- D.  $\Delta H = \sum \Delta H_{\text{reactants}} - \sum \Delta H_{\text{products}}$

*Use the following information to answer the next question.*

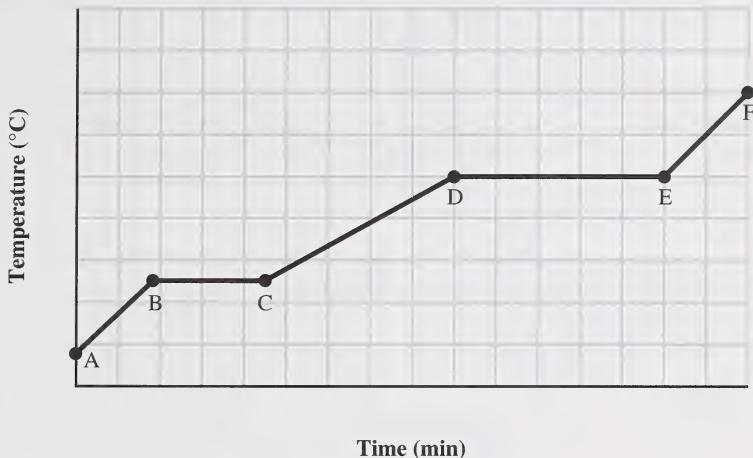


4. Which statement is correct for the indicated reaction?

- A. 205.2 kJ are absorbed per mole of  $\text{H}_{2}\text{O}_{(g)}$  used.
- B. 351.7 kJ are absorbed per mole of  $\text{N}_{2(g)}$  formed.
- C. 615.5 kJ are released per mole of  $\text{HNO}_{3(aq)}$  used.
- D. 492.4 kJ are released per mole of  $\text{N}_{2}\text{H}_{4(g)}$  formed.

*Use the following information to answer the next question.*

A student sketched a temperature versus time graph for the warming of a sample of ice at a constant rate.



5. Sections AB and EF are steeper than section CD because the
- A. change in temperature from C to D is much greater
  - B. heat capacities of  $\text{H}_2\text{O}_{(s)}$  and  $\text{H}_2\text{O}_{(g)}$  are less than that of  $\text{H}_2\text{O}_{(l)}$
  - C. molar heat of vaporization is greater than the molar heat of fusion
  - D. molar heat of formation of  $\text{H}_2\text{O}_{(g)}$  is less than the molar heat of formation of  $\text{H}_2\text{O}_{(l)}$

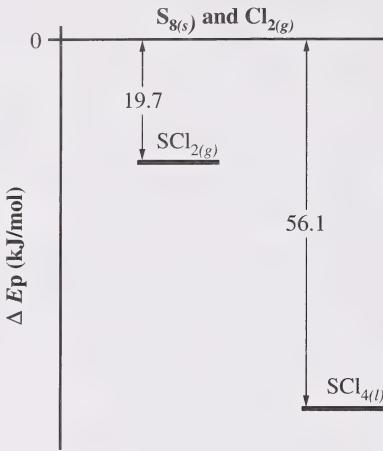
The manufacturing of brick and ceramic products is an important industry in Alberta. High quality clay and sand from quarries in the Cypress Hills are processed in Medicine Hat.

6. The clay and sand are crushed and then mixed with water in large revolving drums. Bricks are made by forcing the wet mixture through specially formed openings in the drums. A typical brick manufactured by this process contains approximately 200 g of  $\text{H}_2\text{O}_{(l)}$  when it is moved to the drying rooms. The loss of water in the drying process would **best** be described as
  - A. a phase change
  - B. a chemical change
  - C. an exothermic change
  - D. a sublimation change
  
7. After being removed from the drying rooms, the bricks are put into kilns. One of the reasons for this is to remove the remaining water from the bricks. At this time, approximately 10.0% of the brick's mass is water. The energy required to remove this water from a 950 g brick at 100°C is
  - A. 215 kJ
  - B. 318 kJ
  - C. 1.27 MJ
  - D. 1.51 MJ

- 8.** Methane, the main component of natural gas, is used as the fuel source to fire the bricks. Assuming it requires 4.00 MJ of heat to warm a single brick to its firing temperature, what mass of methane would be consumed in heating the brick to its firing temperature?
- A. 40.0 g  
B. 60.0 g  
C. 80.0 g  
D. 400 g
- 9.** As the bricks are heated, gases are given off. For example, carbon dioxide and sulphur dioxide are generated in the kiln. The major problem associated with the emission of these oxides is that they
- A. lower the available water in the atmosphere  
B. may combine with water to produce acid rain  
C. lower the available oxygen in the atmosphere  
D. have a cumulative effect in the food chain (biomagnification)

10. The heat of reaction for the complete combustion of methanal according to the equation  $\text{CH}_2\text{O}_{(g)} + \text{O}_{2(g)} \rightarrow \text{CO}_{2(g)} + \text{H}_2\text{O}_{(l)}$  is
- A. -795.2 kJ  
B. -563.4 kJ  
C. -223.6 kJ  
D. +795.2 kJ

Use the following information to answer the next question.



**Numerical Response**

3. The molar heat of reaction for  $\text{SCl}_{4(l)} \rightarrow \text{SCl}_{2(g)} + \text{Cl}_{2(g)}$  is \_\_\_\_\_ kJ/mol.  
(Record your answer to three digits on the answer sheet.)

## Numerical Response

4. Before running, a runner ate a power bar containing 32.5 g of sugar (sucrose). Assuming his energy output is 21.0 kJ/min and the molar heat of combustion of sucrose in the body is –3200 kJ/mol, how many minutes would it take before the energy from the sucrose had been consumed?  
(Record your answer to three digits on the answer sheet.)
11. Cellular respiration,  $\text{C}_6\text{H}_{12}\text{O}_{6(aq)} + 6 \text{O}_{2(g)} \rightarrow 6 \text{CO}_{2(g)} + 6 \text{H}_2\text{O}_{(l)}$ , is a
- A. redox reaction
  - B. neutralization reaction
  - C. single decomposition reaction
  - D. polymerization reaction
12. Which of the following 1.0 mol samples would store the largest amount of energy?
- A.  $\text{H}_2\text{O}_{(l)}$  at 0°C
  - B.  $\text{H}_2\text{O}_{(s)}$  at 0°C
  - C.  $\text{H}_2\text{O}_{(l)}$  at 100°C
  - D.  $\text{H}_2\text{O}_{(g)}$  at 100°C
13. From an environmental point of view and assuming the technology is available, the **best** fuel to burn in a car engine is
- A. hydrogen
  - B. methane
  - C. gasoline
  - D. propane

*Use the following information to answer the next question.*

- |   |          |   |                  |
|---|----------|---|------------------|
| 1 | methane  | 5 | ethyne           |
| 2 | ethene   | 6 | nitrogen dioxide |
| 3 | benzene  | 7 | butane           |
| 4 | methanol | 8 | octane           |

### Numerical Response

- 5.** The compounds that require energy during formation from their constituent elements, listed in numeric order, are \_\_\_\_\_.

(Record all digits of your answer on the answer sheet.)

---

- 14.** Which events could be involved in a phase change?

- A. Overcoming forces among the protons in an atom.
- B. Overcoming forces among the molecules of a liquid.
- C. Overcoming forces within the molecules of a gas.
- D. Breaking bonds between atoms in a molecule.

- 15.** Catalysts are substances that are used industrially or within our bodies to

- A. alter the equilibrium constant
- B. shift the position of the equilibrium system
- C. lower the number of effective collisions between molecules
- D. provide an alternate pathway for chemical changes

16. The reaction  $2 \text{H}_2\text{O}_{(l)} \rightarrow 2 \text{H}_{2(g)} + \text{O}_{2(g)}$  is an example of an

- A. exothermic redox reaction
- B. endothermic redox reaction
- C. exothermic reaction that absorbs energy
- D. endothermic reaction that releases energy

17. In which change are electrons gained?

- A.  $\text{Ca}^{2+}_{(aq)}$  to  $\text{Ca}_{(s)}$
- B.  $2 \text{Cl}^{-}_{(aq)}$  to  $\text{Cl}_{2(g)}$
- C.  $\text{Fe}^{2+}_{(aq)}$  to  $\text{Fe}^{3+}_{(aq)}$
- D.  $\text{NaCl}_{(s)}$  to  $\text{Na}^{+}_{(aq)}$  and  $\text{Cl}^{-}_{(aq)}$

18. Which ion could **not** act as both an oxidizing agent and a reducing agent?

- A.  $\text{Cu}^{2+}_{(aq)}$
- B.  $\text{Sn}^{2+}_{(aq)}$
- C.  $\text{Fe}^{2+}_{(aq)}$
- D.  $\text{Cr}^{2+}_{(aq)}$

19. Bacteria in our mouths and digestive systems convert sodium nitrate and other nitrate salts into nitrites, as indicated by the incomplete and unbalanced half-reaction  $\text{NaNO}_3(aq) \rightarrow \text{NaNO}_2(aq)$ . In this half-reaction,
- the oxidation number for sodium changes from  $-9$  to  $-7$
  - the oxidation number of nitrogen increases
  - the oxidation number of oxygen increases
  - reduction occurs
20. Metals  $\text{W}_{(s)}$ ,  $\text{X}_{(s)}$ ,  $\text{Y}_{(s)}$ , and  $\text{Z}_{(s)}$  were placed in solutions of each of their respective ionic salts. The results are summarized in the data table. A check mark indicates that a reaction occurred.

	$\text{X}^+_{(aq)}$	$\text{Y}^{2+}_{(aq)}$	$\text{Z}^{3+}_{(aq)}$	$\text{W}^+_{(aq)}$
$\text{X}_{(s)}$	—	no reaction	✓	✓
$\text{Y}_{(s)}$	✓	—	✓	✓
$\text{Z}_{(s)}$	no reaction	no reaction	—	✓
$\text{W}_{(s)}$	no reaction	no reaction	no reaction	—

According to the results, the strongest reducing agent is

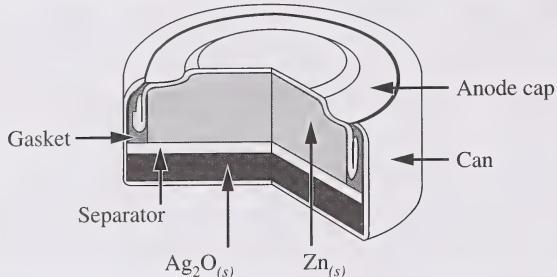
- $\text{Y}^{2+}_{(aq)}$
- $\text{W}_{(s)}$
- $\text{Y}_{(s)}$
- $\text{W}^+_{(aq)}$

*Use the following information to answer the next question.*

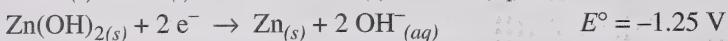
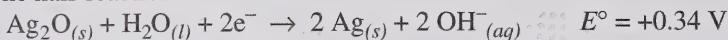
Owners of an acreage had their well water analyzed by the Alberta Research Centre. The well water was found to contain  $\text{Cl}^{-}_{(aq)}$ ,  $\text{I}^{-}_{(aq)}$ ,  $\text{Fe}^{2+}_{(aq)}$ ,  $\text{NO}_3^-_{(aq)}$ ,  $\text{Ni}^{2+}_{(aq)}$ ,  $\text{Zn}^{2+}_{(aq)}$ ,  $\text{Ca}^{2+}_{(aq)}$ , and  $\text{Na}^+_{(aq)}$ .

21. To carry water from the well to their home, the owners should choose a metal pipe made of
- A.  $\text{Fe}_{(s)}$
  - B.  $\text{Cu}_{(s)}$
  - C.  $\text{Cr}_{(s)}$
  - D.  $\text{Al}_{(s)}$
- 
22. When students perform titrations, they use specialized glassware. The glassware listed below that is **not** usually used in a redox or acid-base titration is
- A. a buret
  - B. a pipet
  - C. a test tube
  - D. an Erlenmeyer flask

Silver oxide cells are efficient but expensive because they contain silver. The diagram illustrates the construction of a silver oxide cell.



The half-reactions are:



23. The anode of the cell is

- A.  $\text{Ag}_{(s)}$
- B.  $\text{Zn}_{(s)}$
- C.  $\text{Ag}_2\text{O}_{(s)}$
- D.  $\text{Zn(OH)}_2_{(s)}$

24. Using lowest whole number coefficients, the coefficient for  $\text{H}_2\text{O}_{(l)}$  in the balanced oxidation-reduction reaction that occurs during discharging of the cell is

- A. 1
- B. 2
- C. 3
- D. 4

**25.** As the cell operates, the species oxidized is

- A.  $\text{Ag}_{(s)}$
- B.  $\text{Zn}_{(s)}$
- C.  $\text{Ag}_2\text{O}_{(s)}$
- D.  $\text{Zn}(\text{OH})_{2(s)}$

**26.** As the cell operates, the

- A.  $[\text{OH}^-]_{(aq)}$  increases
- B. mass of  $\text{Zn}_{(s)}$  increases
- C. mass of  $\text{Ag}_2\text{O}_{(s)}$  decreases
- D. mass of  $\text{Zn}(\text{OH})_{2(s)}$  decreases

### Numerical Response

**6.** The voltage generated by the silver oxide cell is \_\_\_\_\_ V.

(Record your answer to three digits on the answer sheet.)

**27.** During the operation of the silver oxide cell,

- A. kinetic energy is converted to chemical energy
- B. chemical energy is converted into electrical energy
- C. electrical energy is converted into potential energy
- D. electrical energy is converted into kinetic energy

The chlor-alkali process used by Dow Chemical in Fort Saskatchewan uses sodium chloride from underground deposits. The sodium chloride is dissolved in water and then pumped into electrolytic cells where a current is passed through the solution to form yellow chlorine gas, colourless hydrogen gas, and aqueous sodium hydroxide. The ionic equation is



28. In the electrolysis of  $\text{NaCl}_{(aq)}$ , the cathode half-reaction is

- A.  $\text{Na}^+_{(aq)} + \text{e}^- \rightarrow \text{Na}_{(s)}$
- B.  $2 \text{Cl}^-_{(aq)} \rightarrow \text{Cl}_{2(g)} + 2 \text{e}^-$
- C.  $2 \text{H}_2\text{O}_{(l)} \rightarrow \text{O}_{2(g)} + 4 \text{H}^+_{(aq)} + 4 \text{e}^-$
- D.  $2 \text{H}_2\text{O}_{(l)} + 2 \text{e}^- \rightarrow \text{H}_{2(g)} + 2 \text{OH}^-_{(aq)}$

### Numerical Response

7. If the mass of the element formed at the anode is 78.1 g, the mass of element formed at the cathode is \_\_\_\_\_ g.

(Record your answer to three digits on the answer sheet.)

29. When the electric current is switched off, the

- A. pH stops decreasing
- B. concentration of the  $\text{Na}^+_{(aq)}$  stops changing
- C. concentration of the  $\text{Cl}^-_{(aq)}$  stops decreasing
- D. concentration of the  $\text{H}_2\text{O}_{(l)}$  stops decreasing

30. Which observation would **not** be useful to determine if the reaction below has reached equilibrium?



- A. The pH
- B. The total gas pressure
- C. The colour of the gas above the liquid
- D. The electrical conductivity of the solution

### Numerical Response

8. The chlorine that is produced by the chlor-alkali process is used to make many products. The oxidation numbers of chlorine for  $\text{ClO}^-(\text{aq})$ ,  $\text{ClO}_4^-(\text{aq})$ ,  $\text{Cl}_{2(\text{g})}$ , and  $\text{ClF}_{5(\text{g})}$ , respectively, are \_\_\_\_\_.  
(Record all four digits on the answer sheet.)

*Use the following information to answer the next question.*

Caustic soda,  $\text{NaOH}(\text{aq})$ , is also produced during the electrolysis of  $\text{NaCl}(\text{aq})$ .

### Numerical Response

9. The pH of a 0.2 mol/L  $\text{NaOH}(\text{aq})$  solution is \_\_\_\_\_.  
(Record your answer to three digits on the answer sheet.)

31. The **best** laboratory method that can be used to determine the concentration of a solution of  $\text{NaOH}(\text{aq})$  is
- A. titration
  - B. distillation
  - C. calorimetry
  - D. extrapolation

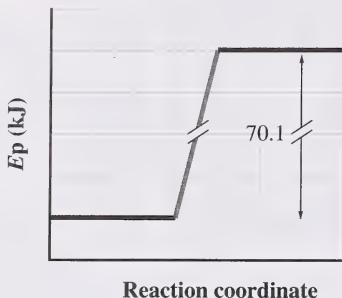
Use the following information to answer the next two questions.

Caustic soda solution,  $\text{NaOH}_{(aq)}$ , is very corrosive and must be handled with care. A caustic soda spill could be neutralized with acetic acid,  $\text{CH}_3\text{COOH}_{(aq)}$ .



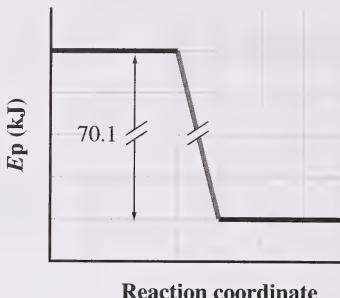
32. The energy diagram that represents the complete neutralization of 50.0 mL of 2.00 mol/L caustic soda solution with acetic acid is

A.



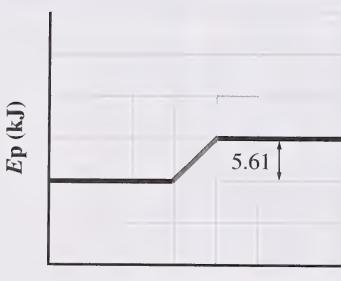
Reaction coordinate

B.



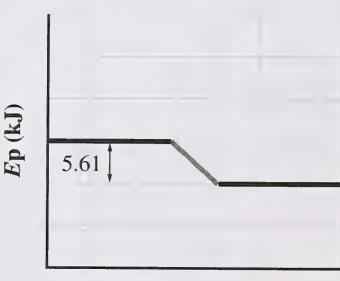
Reaction coordinate

C.



Reaction coordinate

D.



Reaction coordinate

33. In the reaction, a Brønsted-Lowry conjugate acid-base pair is

- A.  $\text{CH}_3\text{COOH}_{(aq)}$  and  $\text{CH}_3\text{COO}^{-}_{(aq)}$
- B.  $\text{CH}_3\text{COOH}_{(aq)}$  and  $\text{OH}^{-}_{(aq)}$
- C.  $\text{CH}_3\text{COOH}_{(aq)}$  and  $\text{H}_2\text{O}_{(l)}$
- D.  $\text{CH}_3\text{COO}^{-}_{(aq)}$  and  $\text{H}_2\text{O}_{(l)}$

- 34.** A chemical equilibrium system is always characterized by
- A. the presence of equal amounts of reactants and products
  - B. the completion of a chemical reaction when changes cease to occur
  - C. equal amounts of reactants and products entering and being removed from the system
  - D. the conversion of reactants to products occurring at the same rate as the conversion of products to reactants

*Use the following information to answer the next question.*

1	lime juice	$[\text{OH}^{-}_{(aq)}]$	$= 7.7 \times 10^{-13}$ mol/L
2	salmon	$[\text{H}_3\text{O}^{+}_{(aq)}]$	$= 6.3 \times 10^{-7}$ mol/L
3	apple cider	$[\text{OH}^{-}_{(aq)}]$	$= 1.3 \times 10^{-11}$ mol/L
4	egg white	$[\text{H}_3\text{O}^{+}_{(aq)}]$	$= 3.0 \times 10^{-8}$ mol/L

**Numerical Response**

- 10.** When these foods are listed from most acidic to least acidic, the order is \_\_\_\_\_.  
(Record all four digits on the answer sheet.)
- 

- 35.** A solution of hydrocyanic acid has a pH of 4.80. The concentration of the  $\text{HCN}_{(aq)}$  solution is
- A. 0.16 mol/L
  - B. 0.25 mol/L
  - C. 0.41 mol/L
  - D. 0.65 mol/L

*Use the following information to answer the next question.*

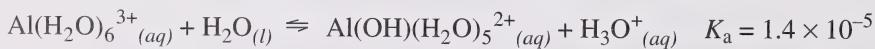
A student sampled four different acids, each at 0.10 mol/L, and she recorded these observations.

	Volume (mL)	pH	Conductivity
Acid I	50.2	4.50	poor
Acid II	40.5	3.25	poor
Acid III	20.7	1.50	good
Acid IV	15.0	5.50	poor

36. The acid that would be expected to have the lowest  $K_a$  value would be
- A. Acid I  
B. Acid II  
C. Acid III  
D. Acid IV
- 
37. The Brønsted-Lowry theory of acids and bases is similar to redox theory in that
- A. most acids can act as oxidizing agents  
B. an oxidizing agent donates electrons and acts like an acid  
C. the base in an acid-base reaction acts like a reducing agent  
D. there is a transfer of a charged particle in both

*Use the following information to answer the next question.*

Manufacturers used to add alum during the production of paper. The aluminum ion in alum is hydrated, and the following equilibrium established:



### Numerical Response

11. If  $[\text{Al}(\text{H}_2\text{O})_6^{3+}_{(aq)}] = 0.150 \text{ mol/L}$ , the pH of the system at equilibrium is \_\_\_\_\_.

(Record your answer to three digits on the answer sheet.)

*Use the following information to answer the next question.*

Kelly tested portions of a solution with three indicators to determine the approximate pH.

Indicator	Colour
bromocresol green	blue
indigo carmine	blue
thymolphthalein	blue

38. The approximate pH of the solution is

- A. 5.0
  - B. 9.0
  - C. 10.8
  - D. 11.6
- 

**Numerical Response**

12. Four test tubes each contain 10.0 mL of 0.10 mol/L  $\text{HCl}_{(aq)}$ . Each test tube also contains a different indicator as listed below:

Test tube	Indicator
1	indigo carmine
2	thymol blue
3	methyl red
4	methyl orange

One drop of 0.10 mol/L  $\text{NaOH}_{(aq)}$  is added to each test tube, and the colour is noted. A second drop of  $\text{NaOH}_{(aq)}$  is added to each test tube, and colour is again observed. The same procedure is repeated until all solutions are yellow. In what order did the solutions in the test tubes turn yellow? \_\_\_\_\_

(Record all four digits on the answer sheet.)

39. The volume of 0.100 mol/L  $\text{NaOH}_{(aq)}$  required to neutralize 1.00 L of a strong monoprotic acid solution with a pH of 3.000 is

- A. 10.0 mL
- B. 333 mL
- C. 1.00 L
- D. 3.00 L

40. Which species is **not** amphiprotic?

- A.  $\text{H}_2\text{O}_{(l)}$
- B.  $\text{HS}^{-}_{(aq)}$
- C.  $\text{NH}_4^+_{(aq)}$
- D.  $\text{H}_2\text{BO}_3^-_{(aq)}$

41. Which acid is **not** polyprotic?

- A.  $\text{HOOCOOH}_{(aq)}$
- B.  $\text{HCOOH}_{(aq)}$
- C.  $\text{H}_2\text{SO}_3_{(aq)}$
- D.  $\text{H}_3\text{PO}_4_{(aq)}$

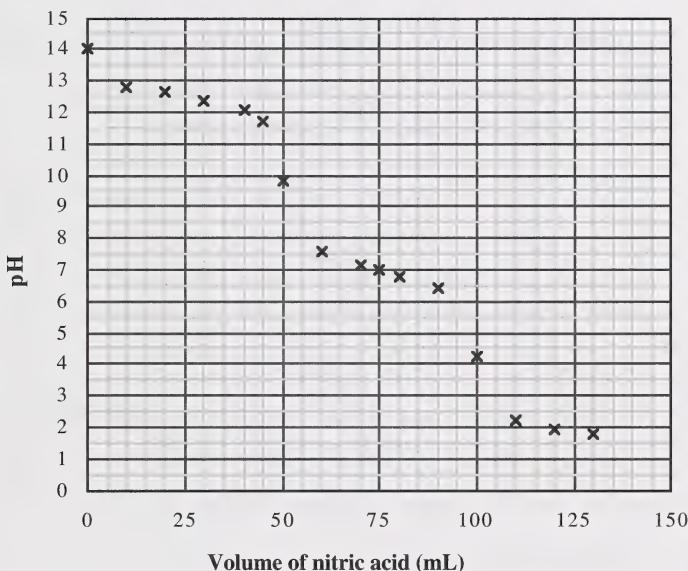
42. When a small volume of a strong acid is added to a buffer, the pH of the solution should

- A. increase
- B. decrease
- C. remain constant
- D. increase first and then decrease

43. Much of the carbon dioxide in the human body is transported on the hemoglobin molecule rather than dissolved in blood because the carbon dioxide would react with the water to form
- A. a basic solution, increasing the pH of the blood
  - B. an acidic solution, increasing the pH of the blood
  - C. a basic solution, decreasing the pH of the blood
  - D. an acidic solution, decreasing the pH of the blood

*Use the following information to answer the next question.*

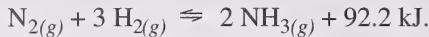
**Titration of an Unidentified Base**



44. Which indicators can be used to accurately estimate the first and second equivalence-points?
- A. Thymolphthalein – methyl orange
  - B. Thymolphthalein – thymol blue
  - C. Alizarin yellow – thymol blue
  - D. All of the above

**Written Response — 15% (12 marks)**

1. The Haber-Bosch process for the industrial production of ammonia involves the equilibrium



In a laboratory experiment designed to study this equilibrium, a chemical engineer injects 0.20 mol of  $\text{N}_{2(g)}$  and 0.60 mol of  $\text{H}_{2(g)}$  into a 1.0 L flask at 500°C. She records her analysis of the contents of the flask at 5 s intervals in the table shown.

Time (s)	Concentration (mol/L)		
	$\text{N}_{2(g)}$	$\text{H}_{2(g)}$	$\text{NH}_{3(g)}$
0	0.20	0.60	0.00
5	0.14	0.42	0.12
10	0.11	0.33	0.18
15	0.10	0.30	0.20
20	0.10	0.30	0.20
25	0.10	0.30	0.20

Analyze the data. Your responses should include

- a plot of the concentrations of  $\text{N}_{2(g)}$ ,  $\text{H}_{2(g)}$ , and  $\text{NH}_{3(g)}$  versus time on the grid provided, including an appropriate title
- the time required to establish equilibrium
- the equilibrium constant for the reaction
- two methods, other than increasing the amounts of reactants, that could increase the yield of ammonia

*For  
Department  
Use Only*



**Written Response — 15% (12 marks)**

2. Explain, in chemical terms, what is meant by the sign in the picture. Your response should also include

- appropriate half-reactions
- an explanation of why this technology would be used
- an example of where this technology would be used



*You have now completed the examination.  
If you have time, you may wish to check your answers.*

*No marks will be given for work done on this page.*



*No marks will be given for work done on this page.*



*No marks will be given for work done on this page.*





# Chemistry 30

## January 1996

Name

Apply Label With Student's Name

Chemistry 30

(Last Name)

Name:

(Legal First Name)

Date of Birth:      
Sex:  Y  M  D

Permanent Mailing Address:

(Apt./Street/Ave./P.O. Box)   
(Village/Town/City)   
(Postal Code)

School Code:    School:

Signature: \_\_\_\_\_

For Department Use Only

Holistic 1

C1

Analytic

C2

Holistic 2

C3

Arbitrator

No Name

Apply Label Without Student's Name



University of Alberta Library



0 1620 0533 0392